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(54) **Improved cleaning of plasma chamber walls by adding of noble gas cleaning step**

(57) An improved reaction chamber and chamber cleaning process are disclosed able to remove water residues by making use of noble-gas plasma reactions. The chamber is easy to operate and the method is easily applicable and may be combined with standard cleaning procedure. A noble-gas plasma (e.g. He) that emits high energy EUV photons (E>20 eV) which is able to destruct water molecules forming electronically excited oxygen atoms is used to remove the adsorbed water.

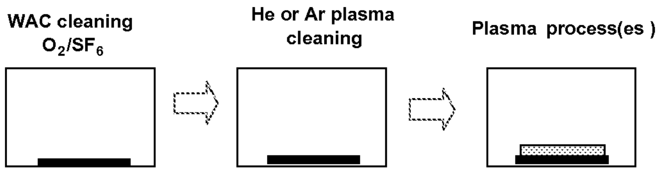

FIGURE 2B

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Description

Technical field of the invention

[0001] The present invention relates to a processing chamber and a method of cleaning a processing chamber such as a reactive ion etching chamber to remove residues such as previously deposited chamber residues, which have accumulated on interior surfaces of the apparatus. In particular, the invention relates to an optimized wafer-less plasma cleaning method for the substantial elimination of residues on interior walls of the processing chamber, or other components inside the processing chamber.

[0002] The chamber or method according to embodiments of the present invention can be used to remove water residues which have been accumulated on the interior of a reaction chamber. Preferably the method of the invention is used in a plasma reaction chamber making use of noble-gas plasma reactions.

Background of the invention

[0003] A critical issue in integration of porous materials, such as e.g. low-k materials, in semiconductor processing is the degradation of their properties, e.g. their dielectric properties as expressed by its dielectric constant k. Porous low-k materials are more sensitive in comparison to conventional dielectric materials such as, for example, silicon dioxide. The open porosity of porous low-k materials significantly increases diffusivity of water species. As a result, polar water groups are incorporated into the porous structure which may increase the dielectric constant or k-value of the material. This leads to an increase in k-value for the porous material and converts the inherently hydrophobic low-k material into a hydrophilic material. Subsequent adsorption of moisture, e.g. water, or other polar molecules having high polarisability, mediated by hydrogen bonding, can significantly increase the effective k-value of the material, e.g. to a k-value >> 80.

[0004] To avoid water absorption and/or water radicals into the pores of the low-k material during patterning of the low-k material in a dry etching chamber it has become increasingly important that the environment inside the processing chamber is clean and that water residues are avoided. As is known in the art, many of the processes carried out within the semiconductor processing chambers leave deposits on the inner surfaces of the processing chamber.

[0005] The currently used chamber walls cleaning recipes in low temperature operating chambers (20°C - 75°C) are introducing water on chamber walls (as a by product reaction of cleaning chemistry with polymers on chamber walls). The water bonded on the chamber walls is released during the plasma processing. The released water is a source of additional O* and H* radicals in the used plasma mixture as shown in Figure 1. The presence of the additional species released from the chamber walls (such as H* and O* radicals) during the process has an influence on the plasma processing of the material. Moreover after the conventional cleaning some amount of particles bonded to the plasma chamber walls still remains.

[0006] The typical plasma cleaning chemistries use SF_6 and O_2 based chemistry. The SF_6 plasma removes polymers on chamber walls and O_2 removes residual carbon but these plasma cleaning chemistries do not remove water residues.

[0007] Therefore there is a need to remove residual water and some part of the remained particles (after previous reactive plasma cleaning) from the plasma chamber walls.

Summary of the invention

[0008] It is an object of the present invention to provide an easy and quick cleaning method to remove residues such as water residues from a processing chamber, e.g. a reaction or plasma chamber (walls).

[0009] An improved reaction chamber and a chamber cleaning process are disclosed that remove residues such as water residues making use of noble-gas plasma reactions.

[0010] The method of the invention is easy applicable and may be combined with standard cleaning procedure. For example, a noble-gas plasma (e.g. He) that emits high energy EUV photons (E>20 eV) which is able to destruct water molecules forming electronically excited oxygen atoms is used to remove the adsorbed water.

[0011] The object is achieved by introducing an additional noble-gas-plasma cleaning step which removes residues such as residual water and some part of the remained particles (preferably after previous reactive plasma cleaning) from the processing chamber walls, e.g. plasma chamber walls.

[0012] The method of the invention can be a modification of currently existing Wafer-Less Auto Cleaning (WAC) recipes. The modification can be realized by adding an additional noble-gas-plasma cleaning step.

[0013] Hence in accordance with embodiments of the present invention, bonded water and molecules (for instance polymer like) on plasma chamber walls can be removed by an additional noble-gas-plasma cleaning step.

[0014] According to preferred embodiments of the invention, the noble-gas-plasma cleaning step is performed using a He or Ar plasma. The energy of ultraviolet (UV) radiation and metastable atoms from the noble gases is sufficient to remove water and also some part of the residual molecules bonded on the plasma chamber walls after previous reactive-plasma cleaning steps.

[0015] The method according to embodiments of the invention can be combined with OES (optical Emission Spectroscopy) to monitor the removal of the contamination.

[0016] In its broadest form, the present invention provides a method for removing residues such as water residues from processing chamber such as a plasma chamber. The method comprises:

- exposing the plasma chamber to a noble gas plasma, the noble gas plasma being able to emit photons having sufficient energy to cause photolysis of water molecules adsorbed on the reaction chamber so as to release radicals of these adsorbed molecules,
- removing the released radicals from the reaction chamber.

[0017] In one embodiment, the present invention further provides a method for monitoring the water contamination in a plasma chamber. The method comprises:

- exposing the plasma chamber to a noble gas plasma, the noble gas plasma being able to emit Extreme Ultra Violet and/or Vacuum Ultra Violet photons having sufficient energy to cause photolysis of water molecules adsorbed to the chamber so as to release oxygen, hydrogen and/or hydroxyl radicals,
- detecting the amount of released oxygen, hydrogen and/or hydroxyl radicals, and
- from the amount of released oxygen, hydrogen and/or hydroxyl radicals quantifying the water contamination of the plasma chamber.

[0018] Detecting the amount of released oxygen, hydrogen and/or hydroxyl radicals may be performed by optical emission spectroscopy, laser induced fluorescence or mass spectrometry.

[0019] According to embodiments of the invention, detecting the amount of released oxygen, hydrogen and/or hydroxyl radicals may be performed by detecting oxygen radicals using optical emission spectroscopy at a predetermined wavelength, e.g. 777 nm.

[0020] The noble-gas plasma cleaning step according to embodiments of the invention is suitable to remove water residues in a reactive ion etching chamber using a He or Ar plasma.

[0021] According to embodiments of the invention, the method may be performed in combination with existing plasma chamber cleaning procedures such as e.g. Wafer-less Auto Clean procedures using a plasma of O_2/SF_6 or an O_2/Cl_2 plasma. These state of the art cleaning procedures are suitable for removing contaminants mainly consisting of organic polymeric residues.

[0022] The present invention also provides a plasma processing chamber adapted for removing water residues from a surface of a material in the plasma chamber, the plasma processing chamber comprising:

- means for introducing a noble gas into the chamber,
- means for exposing the surface to a noble gas plasma, the noble gas plasma being able to emit Extreme Ultra Violet and/or Vacuum Ultra Violet photons having sufficient energy to cause photolysis of water molecules adsorbed to the material so as to release oxygen, hydrogen and/or hydroxyl radicals, and
- means for removing the radicals from the reaction chamber to avoid re-deposition.

The means for exposing the surface to a noble gas plasma are preferably adapted to set a noble-gas pressure in the range 0.39 Pa up to 10.66 Pa, a noble-gas flow in the range of 100 up 1500 sccm, and a plasma power in the range of 400 Watt up to 2000 Watt.

The plasma processing chamber may also have a detector for detecting the amount of released oxygen, hydrogen and/or hydroxyl radicals during exposure of the surface to a noble-gas plasma by optical emission spectroscopy, laser induced fluorescence or mass spectrometry. The detector is preferably adapted to detect the amount of released oxygen, hydrogen and/or hydroxyl radicals is performed by detecting oxygen radicals using optical emission spectroscopy at 777 nm.

The plasma processing chamber can be a reactive ion etching chamber.

[0023] Particular and preferred aspects of the invention are set out in the accompanying independent and dependent claims. Features from the dependent claims may be combined with features of the independent claims and with features of other dependent claims as appropriate and not merely as explicitly set out in the claims.

[0024] The above and other characteristics, features and advantages of the present invention will become apparent from the following detailed description, taken in conjunction with the accompanying drawings, which illustrate, by way of example, the principles of the invention. This description is given for the sake of example only, without limiting the scope of the invention. The reference figures quoted below refer to the attached drawings.

Brief description of the drawings

[0025]

Figure 1 schematically illustrates an Optical emission spectra of pure He plasma recorded in empty chamber. The emissions related to O* (777 nm) and H* (657 nm) radicals are observed.

Figure 2A shows a flow chart illustrating the state of the art plasma chamber cleaning procedure and Figure 2B illustrates the modified state of the art plasma chamber cleaning procedure including the noble-gas plasma cleaning step in accordance with an embodiment of the present invention.

Figure 3 illustrates the 777 nm intensity signal related to O^* radicals (5P-5S transition). Figure. 3A shows the 777 nm intensity signal in the plasma reaction chamber after performing a WAC cleaning recipe and exposure to a He plasma (empty chamber) which is referred to as He pre-cleaning step.

Figure 3B reflects the 777 nm intensity signal in the plasma chamber having a Si wafer inside the chamber. The 777nm signal is higher than that of an empty chamber. This could be related to hydrophilic properties of native Si oxide that covers bare Si. The O* is released from the bonded Si-OH groups.

Figure 3C illustrates the 777 nm intensity signal after processing the Si-wafer and using a He plasma cleaning step (He post-cleaning step) in accordance with an embodiment of the present invention. The 777 nm intensity remains constant, indicating that there are no O* radicals on the walls.

Figures 3D, 3E, and 3F shows the same processing steps as described in Figures 3A, 3B, and 3C above, but without a WAC cleaning step before performing the precleaning step as illustrated in Figure 3A.

Description of illustrative embodiments

[0026] The present invention will be described with respect to particular embodiments and with reference to certain drawings but the invention is not limited thereto but only by the claims. The drawings described are only schematic and are non-limiting. In the drawings, the size of some of the elements may be exaggerated and not drawn on scale for illustrative purposes. The dimensions and the relative dimensions do not correspond to actual reductions to practice of the invention.

[0027] It is to be noticed that the term "comprising", used in the claims, should not be interpreted as being restricted to the means listed thereafter; it does not exclude other elements or steps. It is thus to be interpreted as specifying the presence of the stated features, integers, steps or components as referred to, but does not preclude the presence or addition of one or more other features, integers, steps or components, or groups thereof. Thus, the scope of the expression "a device comprising means A and B" should not be limited to devices consisting only of components A and B. It means that with respect to the present invention, the only relevant components of the device are A and B.

[0028] Reference throughout this specification to "one embodiment" or "an embodiment" means that a particular feature, structure or characteristic described in connection with the embodiment is included in at least one embodiment of the present invention. Thus, appearances of the phrases "in one embodiment" or "in an embodiment" in various places throughout this specification are not necessarily all referring to the same embodiment, but may. Furthermore, the particular features, structures or characteristics may be combined in any suitable manner, as would be apparent to one of ordinary skill in the art from this disclosure, in one or more embodiments.

[0029] Similarly it should be appreciated that in the description of exemplary embodiments of the invention, various features of the invention are sometimes grouped together in a single embodiment, figure, or description thereof for the purpose of streamlining the disclosure and aiding in the understanding of one or more of the various inventive aspects. This method of disclosure, however, is not to be interpreted as reflecting an intention that the claimed invention requires more features than are expressly recited in each claim. Rather, as the following claims reflect, inventive aspects lie in less than all features of a single foregoing disclosed embodiment. Thus, the claims following the detailed description are hereby expressly incorporated into this detailed description, with each claim standing on its own as a separate embodiment of this invention.

[0030] Furthermore, while some embodiments described herein include some but not other features included in other embodiments, combinations of features of different embodiments are meant to be within the scope of the invention, and form different embodiments, as would be understood by those in the art. For example, in the following claims, any of the claimed embodiments can be used in any combination.

[0031] In the description provided herein, numerous specific details are set forth. However, it is understood that embodiments of the invention may be practised without these specific details. In other instances, well-known methods, structures and techniques have not been shown in detail in order not to obscure an understanding of this description.

[0032] The following terms are provided solely to aid in the understanding of the invention.

[0033] The terms "electrostatic chucking" and "electrostatic de-chucking" refer to steps which are used to respectively fix and release a sample, e.g. a wafer, onto or from a wafer holder in a plasma etch chamber. To perform "chucking" or "de-chucking" the wafer can shortly be exposed to a plasma, e.g. a He plasma, to charge or discharge the sample, e.g. wafer, and in that way fix or release the sample, e.g. wafer, onto/from the sample holder.

[0034] The invention will now be described by a detailed description of several embodiments of the invention. It is clear that other embodiments of the invention can be configured according to the knowledge of persons skilled in the art without departing from the technical teaching of the invention, the invention being limited only by the terms of the appended claims.

[0035] The present invention provides a method for removing residues, e.g. water residues from a surface. Preferably the method is used to remove water residues from surface(s) of a plasma reaction chamber by using a noble-gas plasma (referred to as a noble-gas plasma cleaning).

[0036] The method comprises:

- exposing the surface to a noble gas plasma, the noble gas plasma being able to emit Extreme Ultra Violet and/or Vacuum Ultra Violet photons having sufficient energy to cause photolysis of water molecules adsorbed to the surface so as to release oxygen, hydrogen and/or hydroxyl radicals,

- removing the oxygen, hydrogen and/or hydroxyl radicals from the reaction chamber to avoid re-deposition on the surface.

A plasma processing chamber according to the present invention is adapted for removing water residues from a surface of a material in the plasma chamber, the plasma processing chamber may comprise:

- means for introducing a noble gas into the chamber,
- means for exposing the surface to a noble gas plasma, the noble gas plasma being able to emit Extreme Ultra Violet and/or Vacuum Ultra Violet photons having sufficient energy to cause photolysis of water molecules adsorbed to the material so as to release oxygen, hydrogen and/or hydroxyl radicals, and
- means for removing the radicals from the reaction chamber to avoid re-deposition.

[0037] Figure 1 schematically illustrates an Optical Emission Spectra of pure He plasma recorded in empty chamber. The emissions related to O* (777 nm) and H* (657 nm) radicals are observed.

[0038] According to embodiments of the invention the amount of released oxygen, hydrogen and/or hydroxyl radicals may be monitored using optical emission spectrometry (OES).

[0039] The method according to embodiments of the present invention is quick, and easily applicable.

[0040] The method according to embodiments of the invention can be used in combination with state of the art cleaning processes such as Waferless Auto Clean procedures using a plasma of O_2/SF_6 or an O_2/Cl_2 plasma. Preferably the noble-gas plasma cleaning step is performed after the WAC cleaning step.

[0041] According to embodiments of the invention, the adsorption of water onto the surface of a reaction chamber walls may be the result or by-product of the reaction of organic hydrophobic groups during exposure of a material, e.g. during the plasma etching (patterning) of a porous organic low-k material using e.g. an O_2 plasma.

[0042] The plasma chamber or a method according to embodiments of the invention is based on the exposure of a surface to a plasma that is able to emit EUV (Extreme Ultra Violet) and/or VUV (far or Vacuum Ultra Violet) photons having sufficient energy to dissociate water molecules adsorbed to the material so as to release oxygen, hydrogen and/or hydroxyl radicals. The plasma may for example, be a low pressure plasma with a minimum power of approximately 100 Watt (no bias is applied). According to embodiments of the invention the plasma may comprise at least one compound selected from the group of noble gases with an atomic weight less than Xe, such as He and Ar. More heavy noble gases will emit radiation with an energy that is not sufficient to dissociate water. It was found that exposure to a noble gas plasma causes photolysis of water thereby forming O*, OH* and/or H* radicals.

[0043] A plasma chamber or a method according to embodiments of the invention may make use of chemiluminescence. Chemiluminescence or, in other words, emission of light, is the result of a decay from an excited state of a molecule or atom to a lower energy level. In theory one photon of light should be emitted for each molecule or atom going back to a lower energy level. Chemiluminescence can be monitored using optical emission spectrometry (OES).

[0044] Products of the above-described noble-gas plasma cleaning reactions, i.e. O*, OH* and/or H* radicals can be detected by, for example, Optical Emission Spectrometry (OES). Analysis of radiation intensities at particular wavelengths may then reveal information on the level of water contamination. For example, for O* radicals, analysis of radiation intensities at a wavelength of 777 nm may give information about the residual contamination. Furthermore, H* radicals can be monitored at a wavelength of 656 nm and OH* radicals can be monitored at a wavelength of 309 nm. OES may be performed or a spectrum may simultaneously be monitored during the noble-gas plasma cleaning.

[0045] According to embodiments of the invention, the noble-gas plasma cleaning is used to remove water residues from a reaction chamber and a wafer is placed onto the wafer holder (chuck) to protect the wafer holder during exposure to the noble-gas plasma.

[0046] According to embodiments of the invention, the noble-gas plasma cleaning procedure may be carried out (is suitable for) in a LAM Versys2300 STAR plasma chamber equipped with OES (optical emission spectroscopy) analyzer with spectral resolution 2.5 nm. The spectra were recorded in the range of 250 nm - 850 nm.

[0047] According to embodiments of the invention, the plasma chamber is adapted to carry out, or a noble-gas plasma cleaning procedure may be carried out at 30 mTorr 400 W (coil power) and 0 W of bias power during the noble gas (e.g. He) plasma exposure. The noble gas (e.g. He) flow may be 400 sccm. The temperature during the noble-gas plasma cleaning is preferably close to room-temperature up to 70°C, for example 30 °C. The time of He plasma exposure may be 6 seconds for plasma de-chuck and 20 s for chamber cleaning respectively. As shown in Figure 3 the shortest time of noble gas (e.g. He) plasma exposure (with parameters described above) required to clean the chamber is 15 seconds (2.5 longer than for He plasma de-chuck).

[0048] According to embodiments of the invention, the plasma chamber is adapted to carry out, or the noble-gas plasma cleaning procedure may be carried out using a (noble) gas pressure range from 3mTorr (0.39 Pa) up to 80 mTorr (10.66 Pa)

[0049] According to embodiments of the invention, the plasma chamber is adapted to carry out, or the noble-gas plasma cleaning procedure may be carried out for a time period of 15 seconds up to 100 seconds. This exposure time further depends on other parameters such as coil power and gas pressure.

[0050] According to embodiments of the invention, the plasma chamber is adapted to carry out, or the noble-gas plasma cleaning procedure may be carried out using a (noble) gas flow in the range of 100 sccm up to 1500 sccm.

[0051] According to embodiments of the invention, the plasma chamber is adapted to carry out, or the noble-gas plasma cleaning procedure may be carried out using a coil power in the range of 400 W up to 2000 W.

[0052] According to embodiments of the invention, the plasma chamber is adapted to carry out, or the noble-gas plasma cleaning procedure may be carried out using a bias power in the range of 0 W up to 2000 W. Preferably the bias power is around 0 Watt to avoid unwanted ion bombardment effect.

[0053] According to embodiments of the invention, the plasma chamber is adapted to carry out, or the noble-gas plasma cleaning procedure with or without a preceding WAC cleaning step may be performed in a plasma chamber after each processed substrate (wafer) or after a batch of processed wafers.

[0054] Figure 2A shows a flow chart illustrating the state of the art plasma chamber cleaning procedure using a WAC cleaning procedure using an O_2/SF_6 plasma. Figure 2B illustrates the improved plasma chamber cleaning procedure including the noble-gas plasma cleaning step. First a WAC cleaning procedure using an O_2/SF_6 plasma is performed and subsequently the noble-gas cleaning step is applied (e.g. using a He and/or Ar plasma).

[0055] Figure 3 illustrates the 777 nm intensity signal related to O* radicals (5P-5S transition). The time traces were recalculated from He plasma OES spectra. The presented curves follow maximum of 777 nm intensity as shown in Fig.3. For all steps the same He plasma recipe was used. The recipe contains a stabilization step. In this step the chamber is filled with He to the required pressure. Then He plasma is ignited for 20 seconds. This is followed by another plasma stabilization step for 8 s and then 6 s of plasma step. This additional 6 s He plasma step is a standard de-chuck step. De-chuck step is used for removing a wafer from the chuck. Figure. 3A shows the 777 nm intensity signal in the plasma reaction chamber after performing a WAC cleaning recipe and exposure to a He plasma (empty chamber) which is referred to as He pre-cleaning step. In this case, the He pre-cleaning step follows the standard WAC O_2/SF_6-based step. The O_2/SF_6 chemistry is used for the chamber walls cleaning purpose as described in literature[i]. We found that after the WAC O* is released from the chamber walls during the subsequent He plasma treatment. This is reflected by time trace of 777 nm intensity. After 15 s the time trace reaches constant intensity of 1500. This means that chamber walls are cleaned from O*.

[0056] Figure 3B reflects the 777 nm intensity signal in the plasma chamber having a Si wafer inside the chamber. The 777nm signal is higher than that of an empty chamber. This could be related to hydrophilic properties of native Si oxide that covers bare Si. The O* is released from the bonded Si-OH groups.

[0057] Figure 3C illustrates the 777 nm intensity signal after processing the Si-wafer and using a He plasma cleaning step (He post-cleaning step). The 777 nm intensity remains constant, indicating that there are no O* radicals on the walls.

[0058] Figures 3D, 3E, and 3F shows the same processing steps as described in Figures 3A, 3B, and 3C above, but without a WAC cleaning step before performing the pre-cleaning step as illustrated in Figure 3A.

[0059] It is to be understood that although preferred embodiments, specific constructions and configurations, as well as materials, have been discussed herein for devices according to the present invention, various changes or modifications in form and detail may be made without departing from the scope of the present invention as defined by the claims.

Claims

1. A method for removing water residues from a surface of a material in a plasma chamber, the method comprising:

    - exposing the surface to a noble gas plasma, the noble gas plasma being able to emit Extreme Ultra Violet and/or Vacuum Ultra Violet photons having sufficient energy to cause photolysis of water molecules adsorbed to the material so as to release oxygen, hydrogen and/or hydroxyl radicals,
    - removing the radicals from the reaction chamber to avoid re-deposition.

2. The method according to claim 1 wherein the step of exposing the surface to a noble gas plasma is performed using a noble-gas pressure in the range 0.39 Pa up to 10.66 Pa, a noble-gas flow in the range of 100 up 1500 sccm, a plasma power in the range of 400 Watt up to 2000 Watt.

3. The method according to claim 1, further comprising detecting the amount of released oxygen, hydrogen and/or hydroxyl radicals during the step of exposing the surface to a noble-gas plasma by optical emission spectroscopy, laser induced fluorescence or mass spectrometry.

4. The method according to claim 2, wherein detecting the amount of released oxygen, hydrogen and/or hydroxyl radicals is performed by detecting oxygen radicals using optical emission spectroscopy at 777 nm.

5. The method according to any of claims 1 to 3, wherein the method furthermore comprises before the step of exposing the surface to a noble gas plasma the step of performing a Wafer-less Auto Cleaning pro-

cedure using an O_2/SF_6 or an O_2/Cl_2 plasma.

6. The method according to any of the previous claims, wherein the method is used to remove water residues from the inner walls of a reactive ion etching chamber using a He or Ar plasma.

7. The method according to any of the previous claims, wherein the method is performed "in-situ".

8. A plasma processing chamber adapted for removing water residues from a surface of a material in the plasma chamber, the plasma processing chamber comprising:

- means for introducing a noble gas into the chamber,
- means for exposing the surface to a noble gas plasma, the noble gas plasma being able to emit Extreme Ultra Violet and/or Vacuum Ultra Violet photons having sufficient energy to cause photolysis of water molecules adsorbed to the material so as to release oxygen, hydrogen and/or hydroxyl radicals, and
- means for removing the radicals from the reaction chamber to avoid re-deposition.

9. The plasma processing chamber according to claim 8, wherein the means for exposing the surface to a noble gas plasma are adapted to set a noble-gas pressure in the range 0.39 Pa up to 10.66 Pa, a noble-gas flow in the range of 100 up 1500 sccm, and a plasma power in the range of 400 Watt up to 2000 Watt.

10. The plasma processing chamber according to claim 8 or 9, further comprising a detector for detecting the amount of released oxygen, hydrogen and/or hydroxyl radicals during exposure of the surface to a noble-gas plasma by optical emission spectroscopy, laser induced fluorescence or mass spectrometry.

11. The plasma processing chamber according to claim 10, wherein the detector is adapted to detect the amount of released oxygen, hydrogen and/or hydroxyl radicals is performed by detecting oxygen radicals using optical emission spectroscopy at 777 nm.

12. The plasma processing chamber according to any of claims 8 to 11, being a reactive ion etching chamber.

FIGURE 1

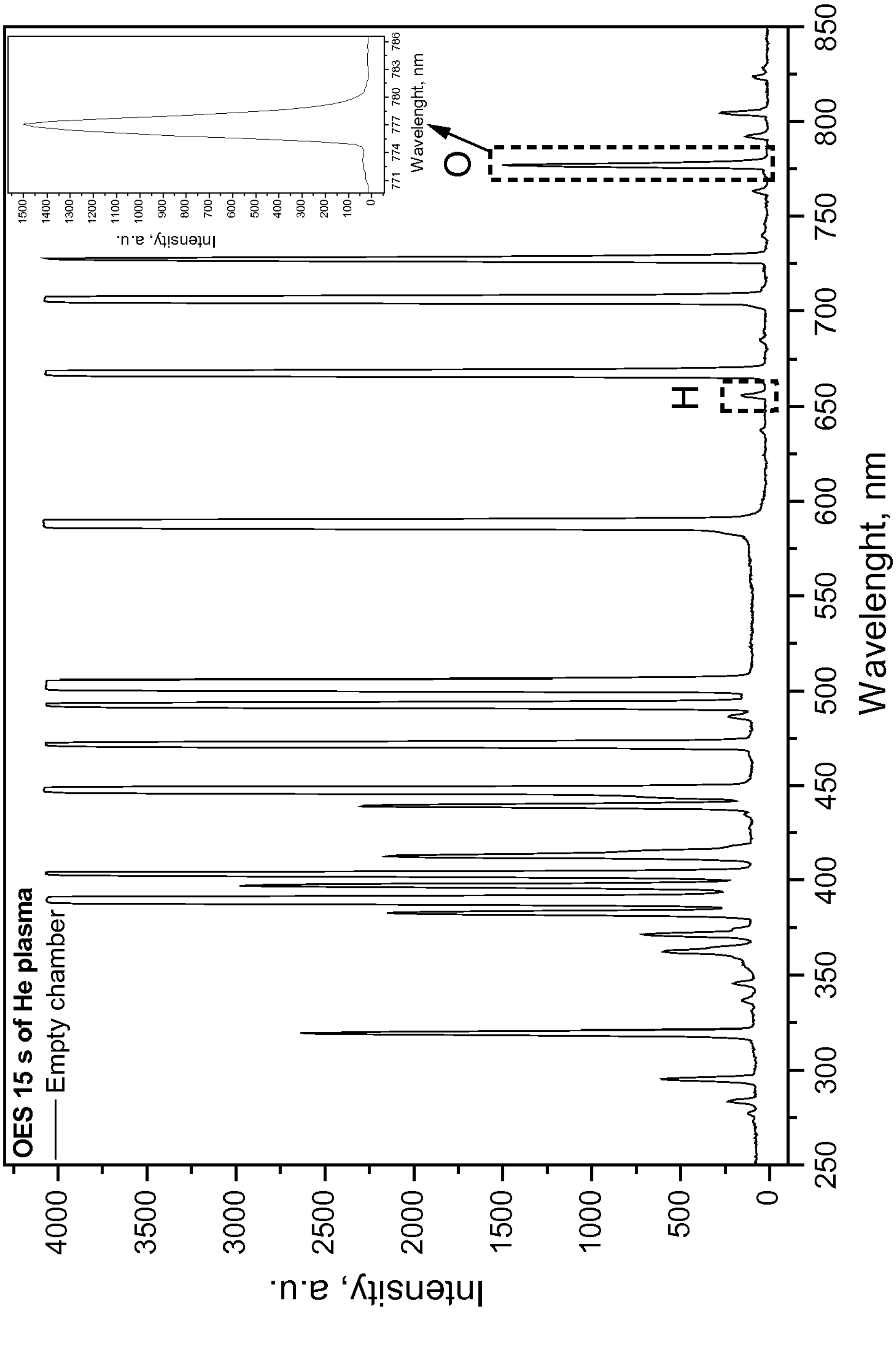
OES 15 s of He plasma
Empty chamber
H
O
Intensity, a.u.
Wavelenght, nm
Intensity, a.u.
Wavelenght, nm

FIGURE 2

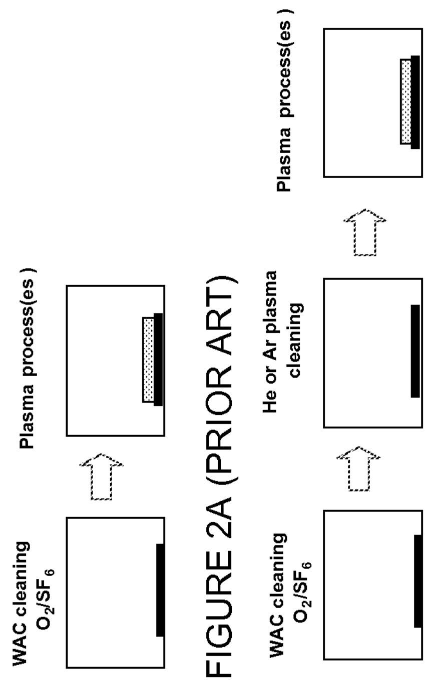

FIGURE 2A (PRIOR ART)

FIGURE 2B

FIGURE 3

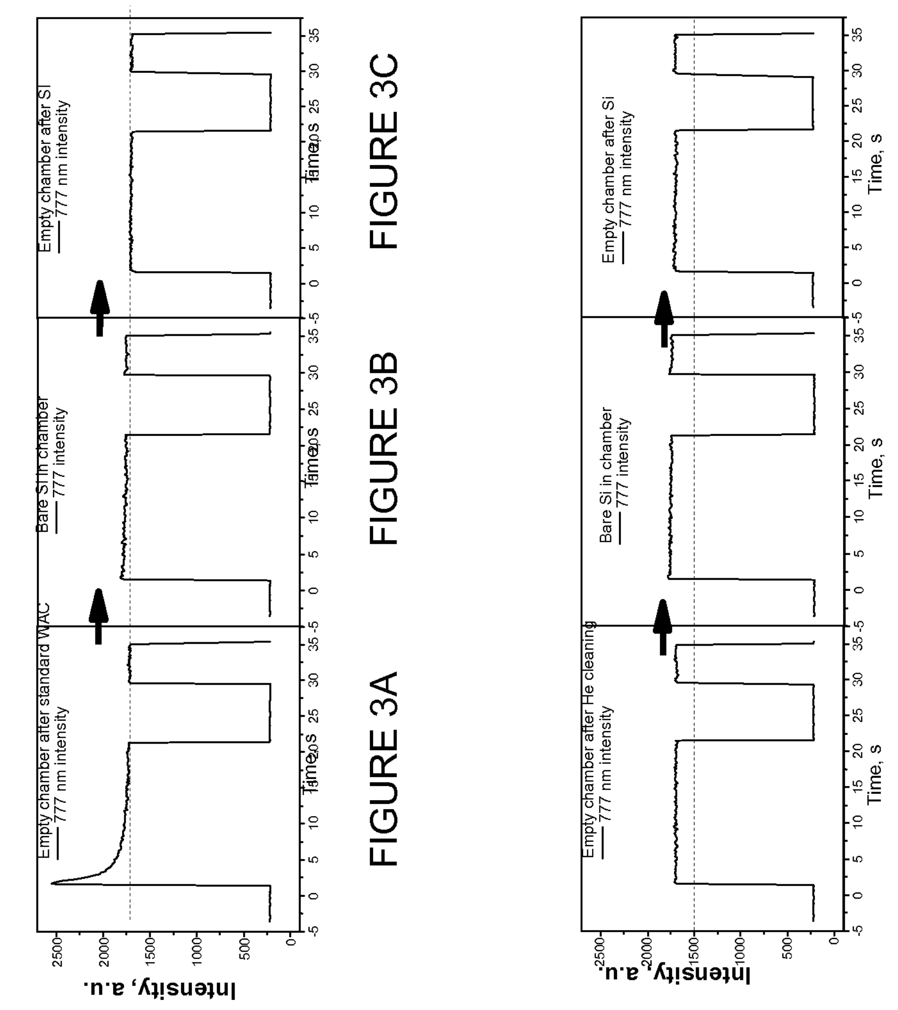

FIGURE 3A FIGURE 3B FIGURE 3C

FIGURE 3D FIGURE 3E FIGURE 3F